

**METHOD, APPARATUS, AND COMPUTER
PROGRAM PRODUCT FOR ADAPTIVE
DEVICE DISCOVERY IN WIRELESS
NETWORKS**

FIELD

[0001] The field of the invention relates to wireless communication and more particularly to device discovery in wireless communication networks.

BACKGROUND

[0002] Perhaps the best-known example of wireless personal area network (PAN) technology is Bluetooth Standard, which operates in the 2.4 GHz ISM band. Bluetooth is a short-range radio network, originally intended as a cable replacement. Bluetooth Technical Specifications are published by the Bluetooth SIG, Inc. *Bluetooth Specification version 2.0+EDR*, published Oct. 15 2004 has the original functional characteristics of the first version Bluetooth Basic Rate (BR) and adds the Enhanced Data Rate (EDR) feature. *Bluetooth Specification version 2.1+EDR*, published Jul. 26 2007 for Basic Rate/Enhanced Data Rate (BR/EDR), added definitions for new features: Encryption Pause Resume, Erroneous Data reporting, Extended Inquiry Response, Link Supervision Timeout Event, Packet Boundary Flag, Secure Simple Pairing, Sniff Subrating. *Bluetooth Specification version 3.0+HS*, published Apr. 21 2009, updated the standard to integrate the Alternate MAC/PHY and Unicast Connectionless Data features.

[0003] On Apr. 20, 2009, Bluetooth SIG presented the new Bluetooth Low Energy protocol. Bluetooth Low Energy (LE) is a communication protocol directed to optimize power consumption of devices while being connected to other devices. The Bluetooth Low Energy packets include a preamble used for radio synchronization, an access address used for physical link identification, a shorter protocol data unit (PDU) to carry the payload data and the PDU header information, and a cyclic redundancy code (CRC) to ensure correctness of the data in the PDU.

[0004] On Jun. 30, 2010, the Bluetooth SIG published the *Bluetooth Core Specification, Version 4.0* (incorporated herein by reference), which includes the Bluetooth Low Energy (LE) protocol for products that require lower power consumption, lower complexity, and lower cost than would be possible using the BR/EDR protocol. Bluetooth LE is designed for applications requiring lower data rates and shorter duty cycles, with a very-low power idle mode, a simple device discovery, and short data packets. Bluetooth LE devices employ a star topology, where one device serves as a master for a plurality of slave devices, the master dictating connection timing by establishing the start time of the first connection event and the slave devices transmitting packets only to the master upon receiving a packet from the master. According to Bluetooth LE communication protocol all connections are point-to-point connections between two devices (the master and the slave).

SUMMARY

[0005] Method, apparatus, and computer program product example embodiments enable wireless communication devices to reduce connection latency in high device population environments.

[0006] According to an example embodiment of the invention, a method comprises:

[0007] creating, at an apparatus, operating parameters for a wireless data channel connection and descriptive information regarding a time interval available to the apparatus for transmission of advertising channel messages and a count of a number of previous transmissions of the advertising channel messages to reduce connection latency in high device population environments;

[0008] transmitting, by the apparatus, one or more wireless advertising channel messages indicating presence of the wireless data channel connection, the operating parameters associated with the wireless data channel connection, and the descriptive information regarding the time interval available to the apparatus for transmission of advertising channel messages and the count of the number of previous transmissions of the advertising channel messages; and

[0009] transmitting, by the apparatus, information on the wireless data channel connection according to the operating parameters.

[0010] According to an example embodiment of the invention, a method comprises:

[0011] wherein the wireless advertising channel message is transmitted on a Bluetooth Low Energy advertising channel and messages transmitted on the wireless data channel are transmitted on a Bluetooth Low Energy data channel.

[0012] According to an example embodiment of the invention, a method comprises:

[0013] wherein the wireless advertising channel message includes an advInterval value indicating the time interval available to the apparatus for transmission of advertising channel messages.

[0014] According to an example embodiment of the invention, a method comprises:

[0015] entering, by the apparatus, a connected state with another device responding to the advertising channel messages; and

[0016] resetting, by the apparatus, the count of the number of previous transmissions of the advertising channel messages, after the apparatus enters the connected state.

[0017] According to an example embodiment of the invention, a method comprises: wherein the operating parameters included in the wireless advertising channel messages enable a receiving device to receive the information transmitted on the wireless data channel connection.

[0018] According to an example embodiment of the invention, a method comprises:

[0019] receiving, by an apparatus, one or more wireless advertising channel messages that include descriptive information regarding a time interval available to the sender for transmission of advertising channel messages and a count of a number of previous transmissions of the advertising channel messages by the sender to reduce connection latency in high device population environments;

[0020] computing a total time interval consumed by the sender in previous transmissions of the advertising channel messages, based on the received descriptive information regarding the time interval available to the sender for transmission of advertising channel messages and the count of the number of previous transmissions of the advertising channel messages by the sender; and

[0021] adjusting, by the apparatus, an amount of time for receiving advertising channel messages, based on the com-